Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

A QUANTITATIVE STUDY OF THE EFFECT OF ANIONS ON THE PERMEABILITY OF PLANT CELLS. II

Oran L. Raber

(Received for publication January 20, 1921)

Studies on the effect of certain anions upon permeability were reported in a previous paper (1). The present paper extends the list of anions, including both organic and inorganic. The field is very limited because of the restrictions of solubility, osmotic pressure, acidity, etc., which were mentioned in a previous paper. The sodium salts which seemed to offer the fewest possible difficulties were chlorate, dichromate, molybdate, sulphite, acid arsenate, ferrocyanide, formate, propionate, lactate, butyrate, and salicylate. The following table shows the acidity and concentrations of the solutions:

Salt	Approximate pH	Approximate Mol. Conc.
$NaClO_3$	6	0.61
$Na_2SO_3.7H_2O$	11	0.35
$Na_2Cr_2O_7.2H_2O$	3	0.29
$Na_2MoO_4.2H_2O$	6	0.39
$Na_2HAsO_4.7H_2O$	8	0.34
$Na_4Fe(CN)_6.12H_2O$	8	0.13
$NaCHO_2.H_2O$ (formate)	10	0.56
$NaC_3H_5O_3$ (lactate)	6	1.61
$NaC_4H_7O_2$ (butyrate)	10	1.70
$NaC_3H_5O_2$ (propionate)	9	1.74
$NaC_7H_5O_3$ (salicylate)	6	1.29

With one exception the pH values lie within the limits which Osterhout (2) has shown to have no effect upon permeability (in sea water). In every case, with the exception of the ferrocyanide and the molybdate, the conductivity was that of normal sea water. In both the latter cases the conductivity was approximately that of 75 percent sea water plus 25 percent distilled water.

Figure 1 shows the results, the curve for each salt representing an average of three experiments. The probable error of the mean (as based on Peter's formula) is always under 10 percent of the mean (and for 75 percent of the points under 5 percent).

It will be noted that the univalent anions (formate and chlorate), the bivalent (molybdate and sulphite), and the trivalent (arsenate) fall into three separate groups, as in the case of the anions previously reported (1).

It might be expected that the ferrocyanide would cause a very rapid decrease in resistance since it is a tetravalent ion, and its failure to do so

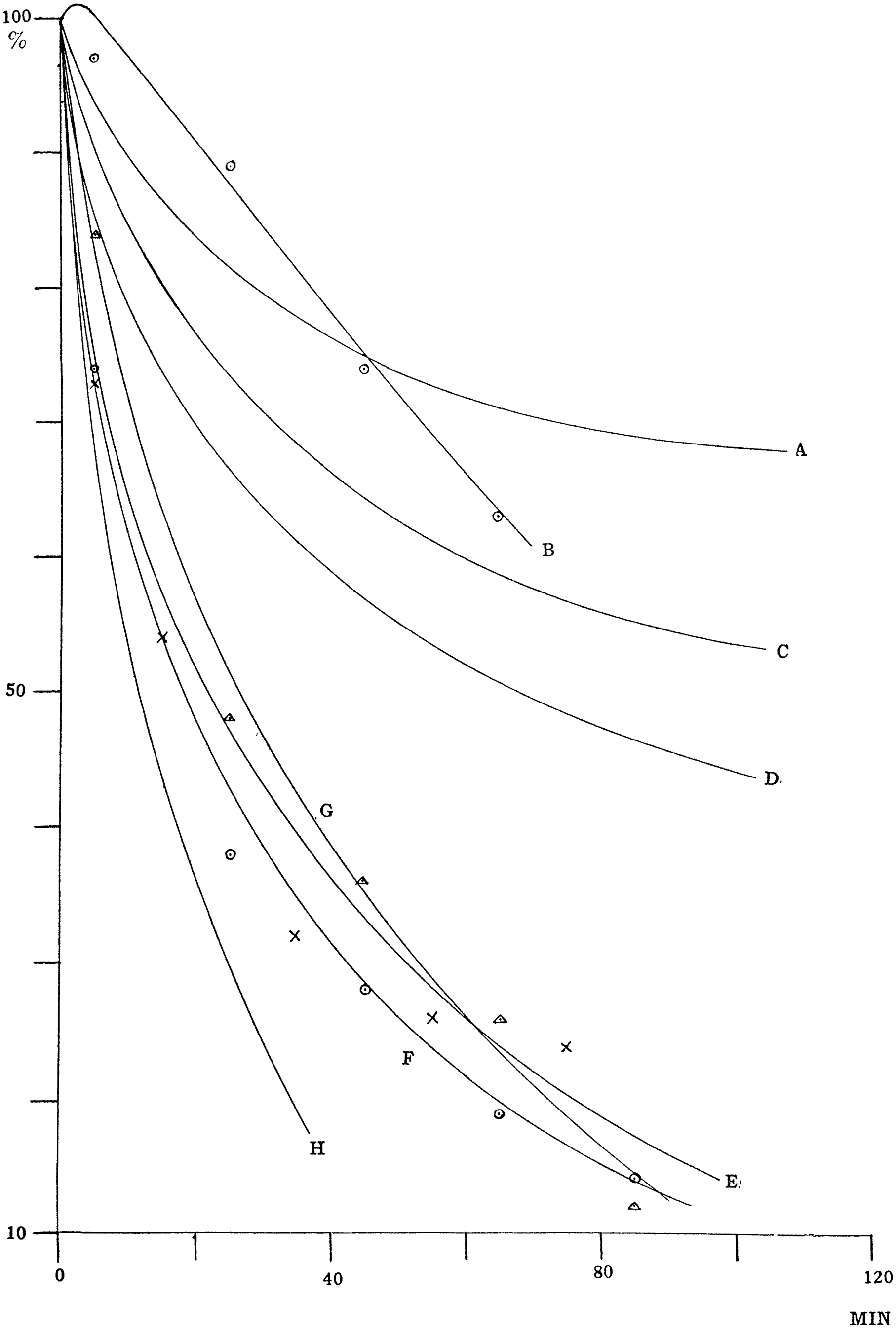

FIG. 1. Curves showing the changes of resistance of Laminaria in solutions of various sodium salts: *A* in chloride; *B* in dichromate; *C* in chlorate; *D* in formate; *E* in molybdate (to judge from the points in the figure this might be drawn so as to fall less rapidly toward the end, but the form given seems to represent the results better); *F* in sulphite; *G* in ferrocyanide; *H* in acid arsenate. Ordinates represent resistance (expressed as percentage of the resistance in sea water, which is taken as 100 percent). Abscissae represent time in minutes. Each point represents the average of three experiments. Probable error of the mean, less than 10 percent of the mean.

may be explained on the basis of its small molecular concentration (0.13 M). If all these salts were of the same molecular strength, they would doubtless be found to fall into four groups depending on their valency.

The sodium dichromate forms an exception because of its acidity. The acidity is slightly higher than the limit which was shown by Osterhout (2) to be without effect on permeability, with the result that there is a very small initial increase followed by a slow but steady decrease. This indicates antagonism between the hydrogen ion and the anion.

It is also interesting to note that, although arsenic is usually regarded as a very toxic substance, the effect of the arsenate does not seem to be any greater than that of any other salt with trivalent anion.

Among the organic salts only formate gave useful results. The osmotic effects produced by the high concentrations necessary in the cases of the propionate, lactate, butyrate, and salicylate cause a very sudden fall of resistance. The effect upon the tissue, however, is very different from that produced by a salt like sodium citrate. In the former cases the tissue simply becomes flabby without undergoing any other noticeable change. In the case of sodium citrate (and similar salts), where the rapid fall is not due to plasmolysis, the tissue becomes decidedly gelatinous and presents a very different appearance.

The results indicate that the effects upon permeability depend upon the valency of the anion regardless of whether the salts are organic or inorganic.

LABORATORY OF PLANT PHYSIOLOGY,
HARVARD UNIVERSITY

BIBLIOGRAPHY

1. **Raber, O. L.** A quantitative study of the effect of anions on the permeability of plant cells. Jour. Gen. Physiol. **2**: 535. 1920.
2. **Osterhout, W. J. V.** The effect of acid on permeability. Jour. Biol. Chem. **19**: 493. 1914.